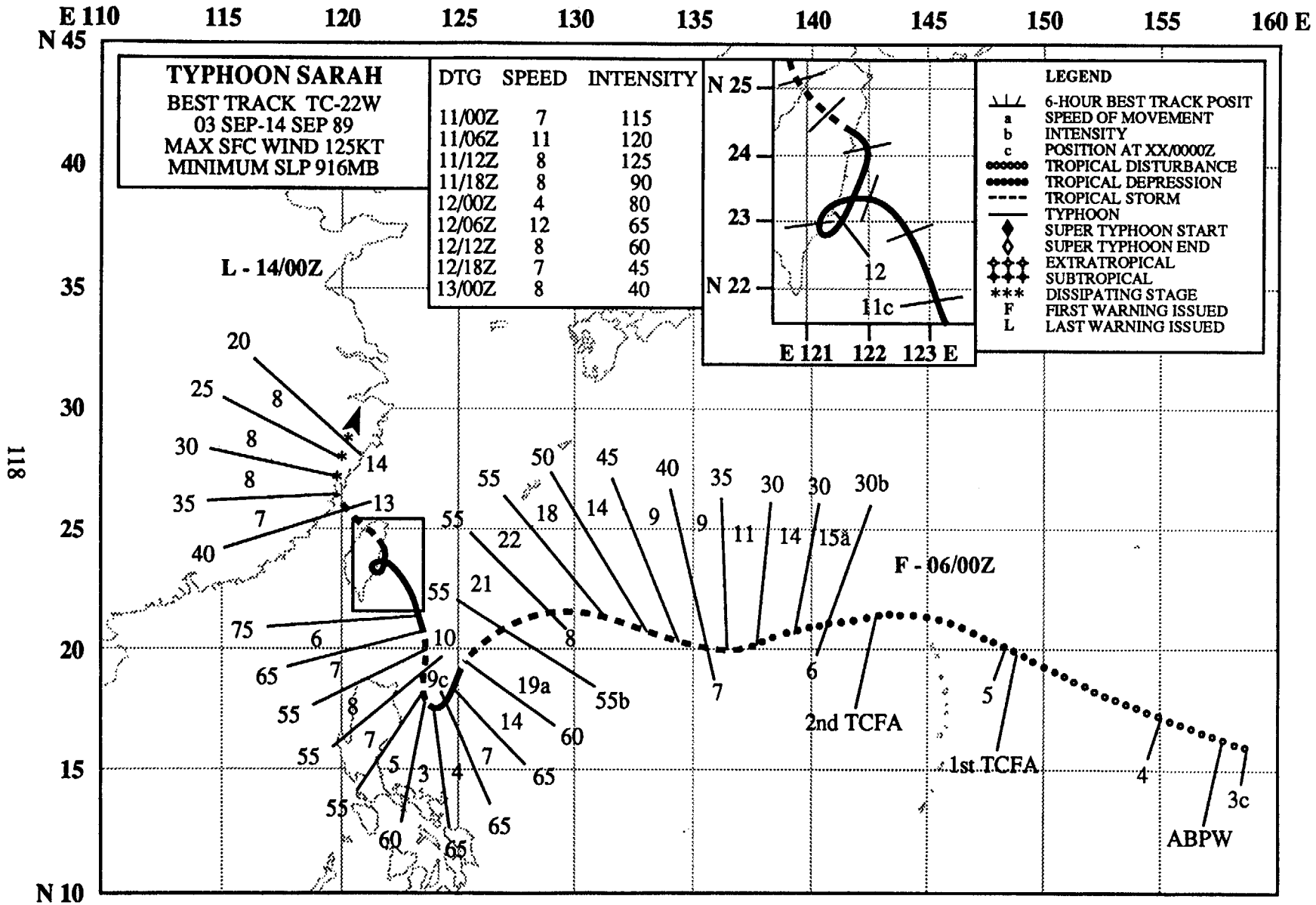

TYPHOON SARAH
BEST TRACK TC-22W
03 SEP-14 SEP 89
MAX SFC WIND 125KT
MINIMUM SLP 916MB
DTG SPEED INTENSITY
11/00Z 7 115
11/06Z 11 120
11/12Z 8 125
11/18Z 8 90
12/00Z 4 80
12/06Z 12 65
12/12Z 8 60
12/18Z 7 45
13/00Z 8 40
LEGEND
6-HOUR BEST TRACK POSIT
a SPEED OF MOVEMENT
b INTENSITY
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED
L - 14/00Z
F - 06/00Z
2nd TCFA
1st TCFA
ABPW
E 110
115
120
125
130
135
140
145
150
155
160 E
N 45
40
35
30
25
20
15
N 10
N 25
24
23
N 22
E 121
122
123 E
118

TYPHOON SARAH (22W)

The first of the September tropical cyclones, Sarah proved to be a bona fide challenge to forecasters. The cyclone apparently underwent a binary interaction with a secondary low east of Luzon and later, when it stalled, was involved with the development of a sympathetic low* on the lee side of Luzon. From genesis involving two distinct cloud masses to accelerating toward the Philippines, stalling just east of Luzon, moving north and rapidly reintensifying, then looping over eastern Taiwan, Sarah was one of the most difficult storms of the year to forecast.

The first day of September, the monsoon trough stretched across the western Pacific in a southwest to northeast orientation between 10° to 20° north latitude, and supported several discrete convective cloud masses. Near Minami Tori-shima, a distinct TUTT cell was evident in satellite imagery. About 600 nm (1110 km) to the southeast, a disturbed area of weather persisted in the monsoon trough. There was little convection associated with the TUTT cell, however, the convection associated with the disturbance was listed on the Significant Tropical Weather Advisory. Two Tropical Cyclone Formation Alerts were issued before the first warning. Complex interactions between the TUTT cell, the disturbance and a second disturbance resulted in conditions favorable for development, and the first warning on Tropical Depression 22W was issued at 060000Z.

The Depression tracked as forecast to the west and was upgraded to Tropical Storm Sarah on the 061800Z warning. By midday on 7 September, Sarah started to accelerate to the northwest towards Okinawa and the tropical storm was relocated on the 071800Z to reflect the acceleration.

Forecasters at JTWC expected the northwestward motion to be short-lived and predicted a turn back to the west. However, on 8 September, the tropical storm turned west-southwest, then south-southwest, and nearly stalled east of Luzon on 9 September. Binary interaction with a secondary low appeared to be

* The formation of a sympathetic low is documented in relation to systems approaching Taiwan (Brand and Blelloch, 1973), but not for systems off the Philippine Islands

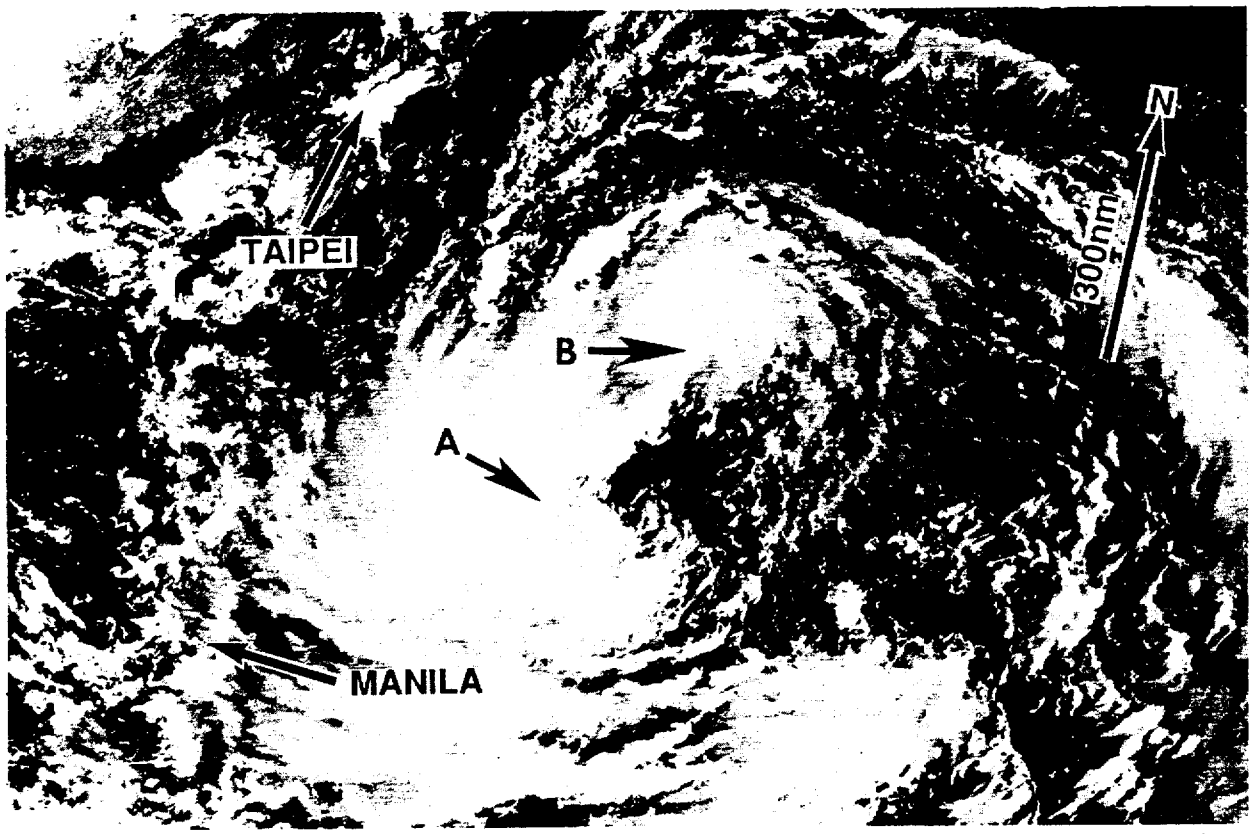
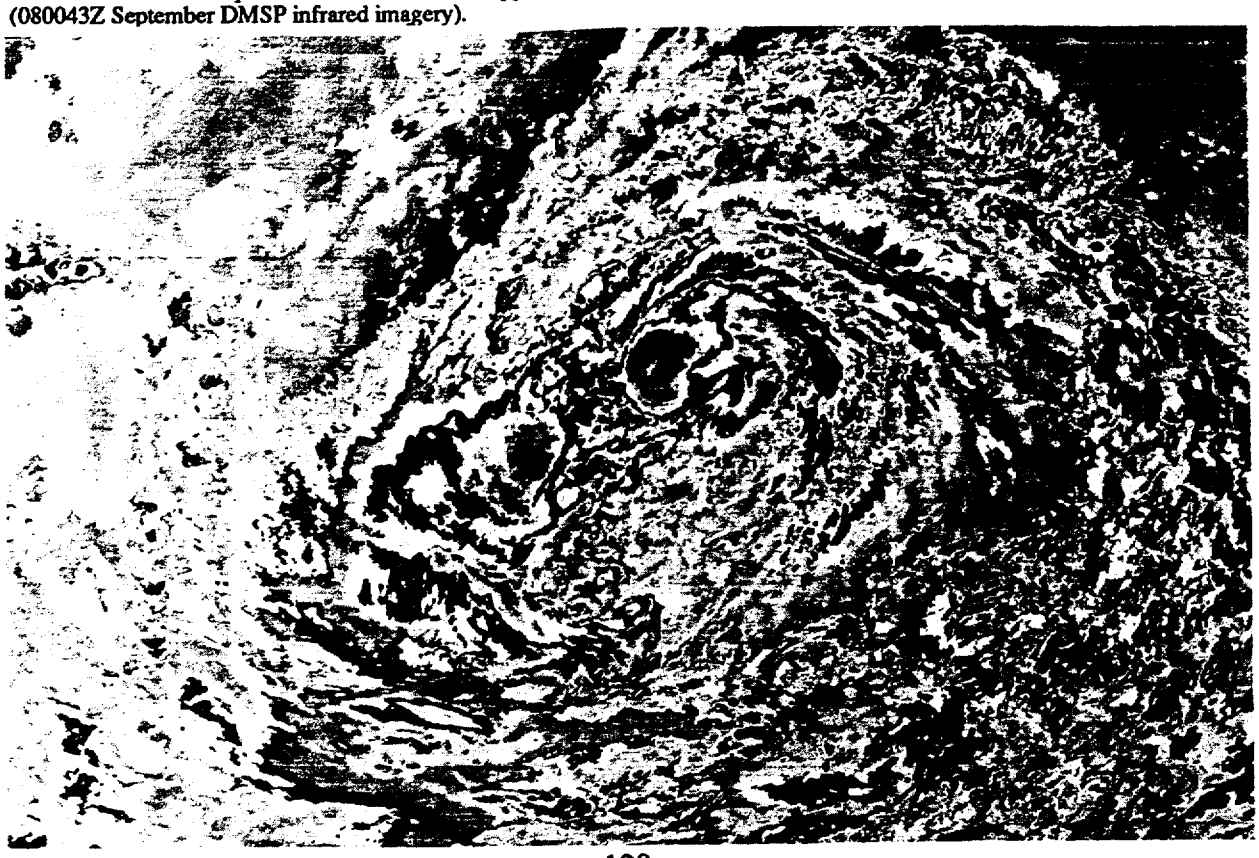


Figure 3-22-1. Matched pair of visual (above) and enhanced infrared (below) images showing two centers of convection. Point A is the mass of persistent convection that appears to have undergone binary interaction with Sarah which is at point B (080043Z September DMSP infrared imagery).



the cause for Sarah's unusual movement. While there was a persistent convective mass (Figure 3-22-1) on the satellite images, there was no firm evidence of this secondary low at the surface on 8 September.

Upgraded to typhoon intensity at 081800Z, Sarah drifted south slowly and then abruptly headed north. During this time, a sympathetic lee-side low (Figure 3-22-2) formed along the northwest side of Luzon. As Sarah moved north, the cloud mass associated with this lee-side low crossed Basco Island north of Luzon and tracked rapidly around the east side of Sarah and to the northeast. Since Basco Island (WMO 98135) reports did not indicate a wind shift as the convective mass passed by, no Alert on this secondary convective area was issued. Sarah's prolonged stay just east of Luzon, coupled with the enhanced southwesterly monsoon flow being drawn over the Philippine Islands resulted in at least 31 fatalities, and extensive property and crop damage on Luzon. In addition, rare tornadoes touched down on 10 September. One caused approximately $150,000 of damage to the San Miguel Naval Communications Station located 38 nm (70 km) northwest of Manila. No other U. S. military installations reported major damage. Camp John Hay located near Baguio reported the strongest winds observed at a U.S. military installation of 42 - 48 kt (22-25 m/sec) during the period from 091500Z to 110430Z.

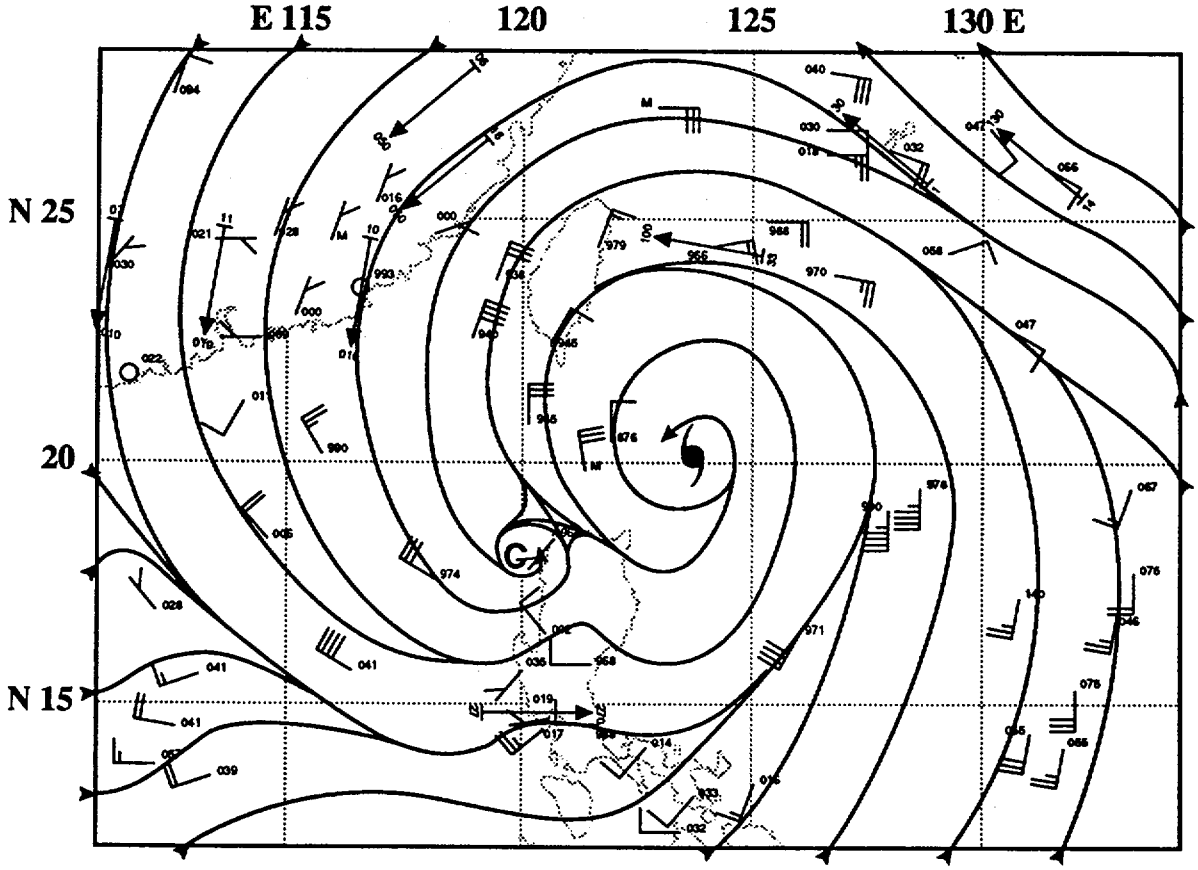


Figure 3-22-2. 101220Z surface/gradient wind analyses shows the sympathetic low along the northwest coast of Luzon.

Moving north into an area of efficient multiple outflow channels, Sarah (Figures 3-22-3 and 3-22-4) explosively deepened. The typhoon peaked at 125 kt (64 m/sec) before interaction with the rugged mountains of Taiwan caused it to weaken. On 10 September, the typhoon was forecast to track north, passing approximately 60 nm (110 km) east of Taiwan on 11 September. It was expected to merge with an approaching mid-latitude front and recurve to the northeast into Kyushu, Japan. Although this was the overall track taken by the secondary cloud maximum that had formed on the lee-side of Luzon and looped around the east side of Sarah as both systems moved north, Sarah did not follow suit. Sarah moved onshore Taiwan with maximum winds near 90 kt (46 m/sec). It then tracked south a short distance along the eastern edge of the mountain range and finally completed a counterclockwise loop off the coast. Approximately 12 hours later, Sarah reentered the coast farther north, weakened and was downgraded to a tropical storm Sarah at 121200Z as it crossed the rugged mountains of Taiwan. The cyclone did not regain its organization as it crossed the Taiwan

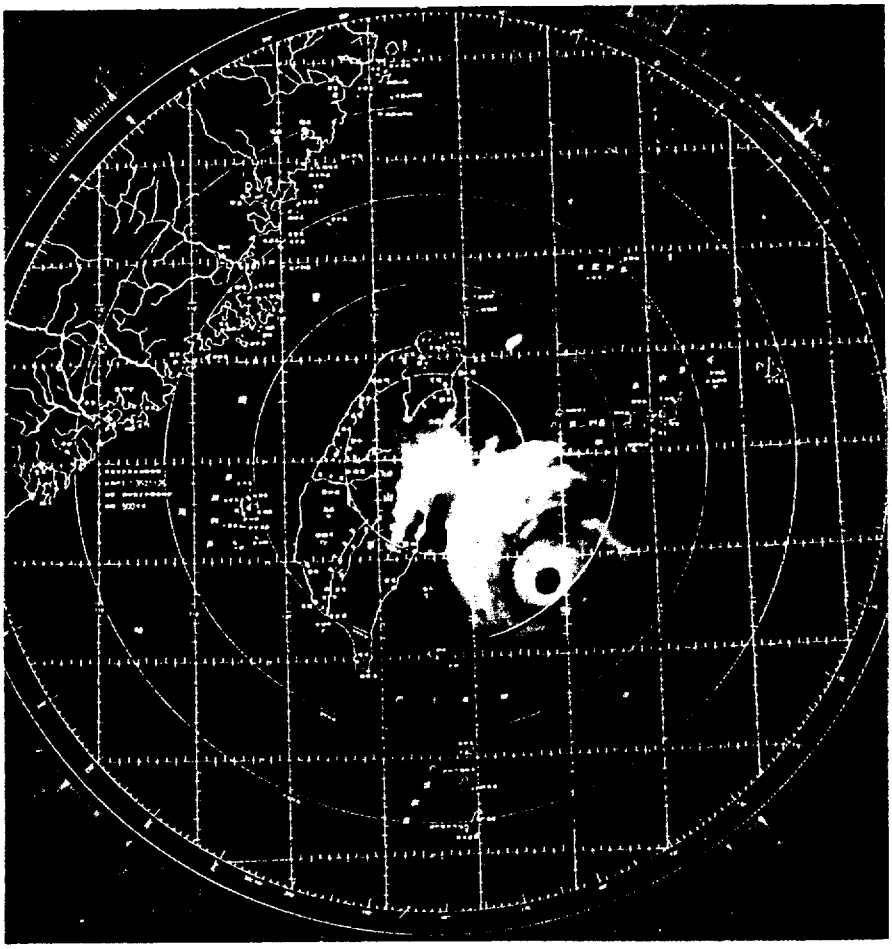


Figure 3-22-3. Radar display of Sarah from Hualien (WMO 46699) at 110500Z. Comparison with Figure 3-22-4, which is close in time, shows the contrast between the remotely sensed precipitation echoes from radar and the cloud top topography as viewed from space (photograph courtesy of the Central Weather Bureau, Taipei, Taiwan).

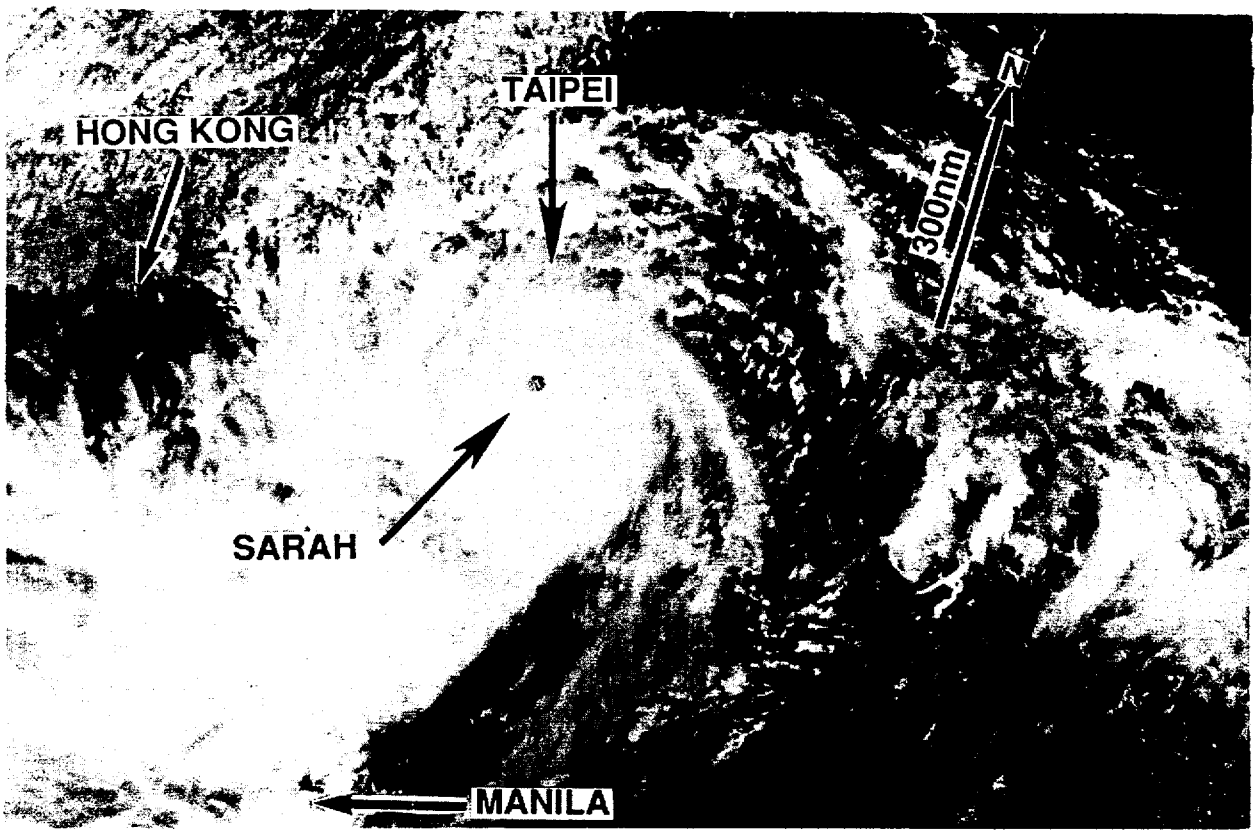
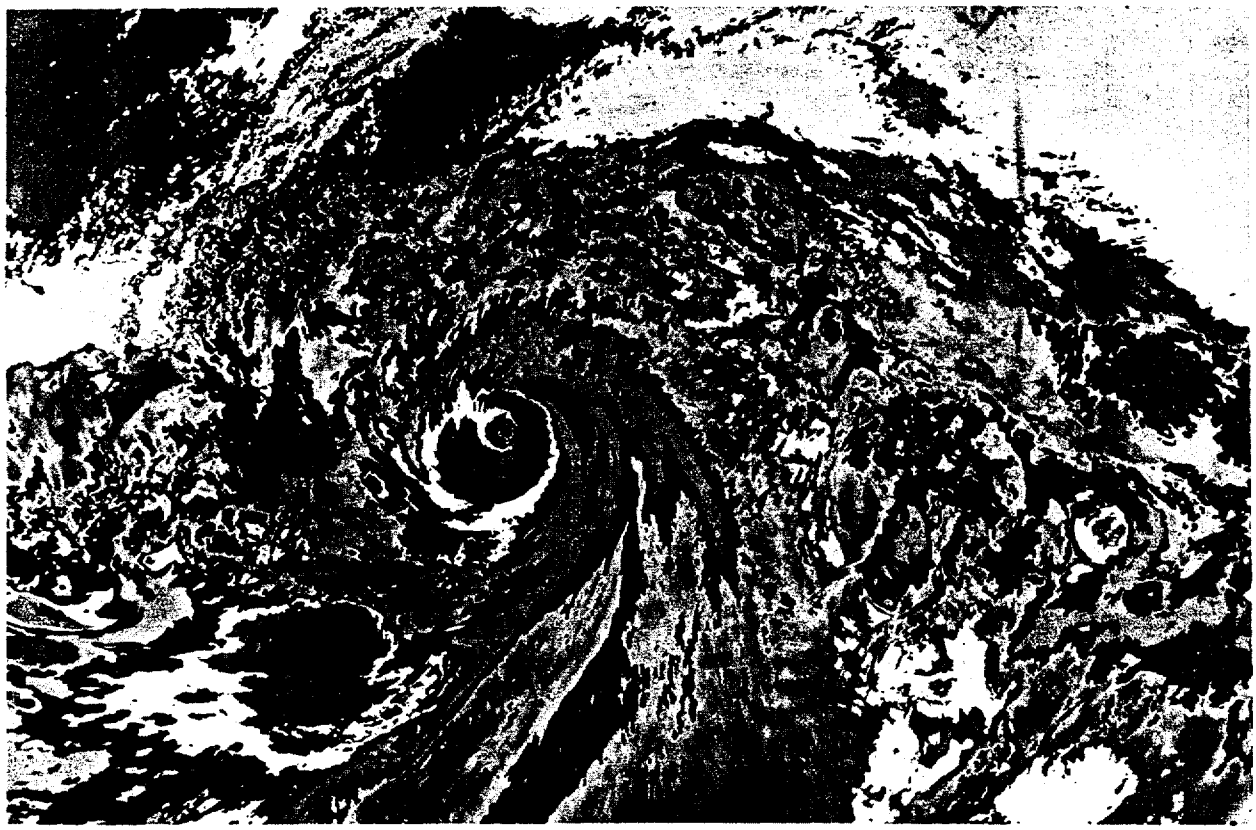


Figure 3-22-4. Matched visual (above) and enhanced infrared (below) pair of images showing Sarah near peak intensity (100517Z September DMSP visual and infrared imagery).



Straits and was downgraded to a tropical depression after it entered the eastern coast of China at 130600Z (Figure 3-22-5). The last warning was issued at 140000Z as the system dissipated over eastern China. Press reports indicated that 13 people died on Taiwan, and that the 12000-ton freighter **Lung Hao** (Figure 3-22-6) broke in half off Hualien, Taiwan. No reports of damage were received from China.

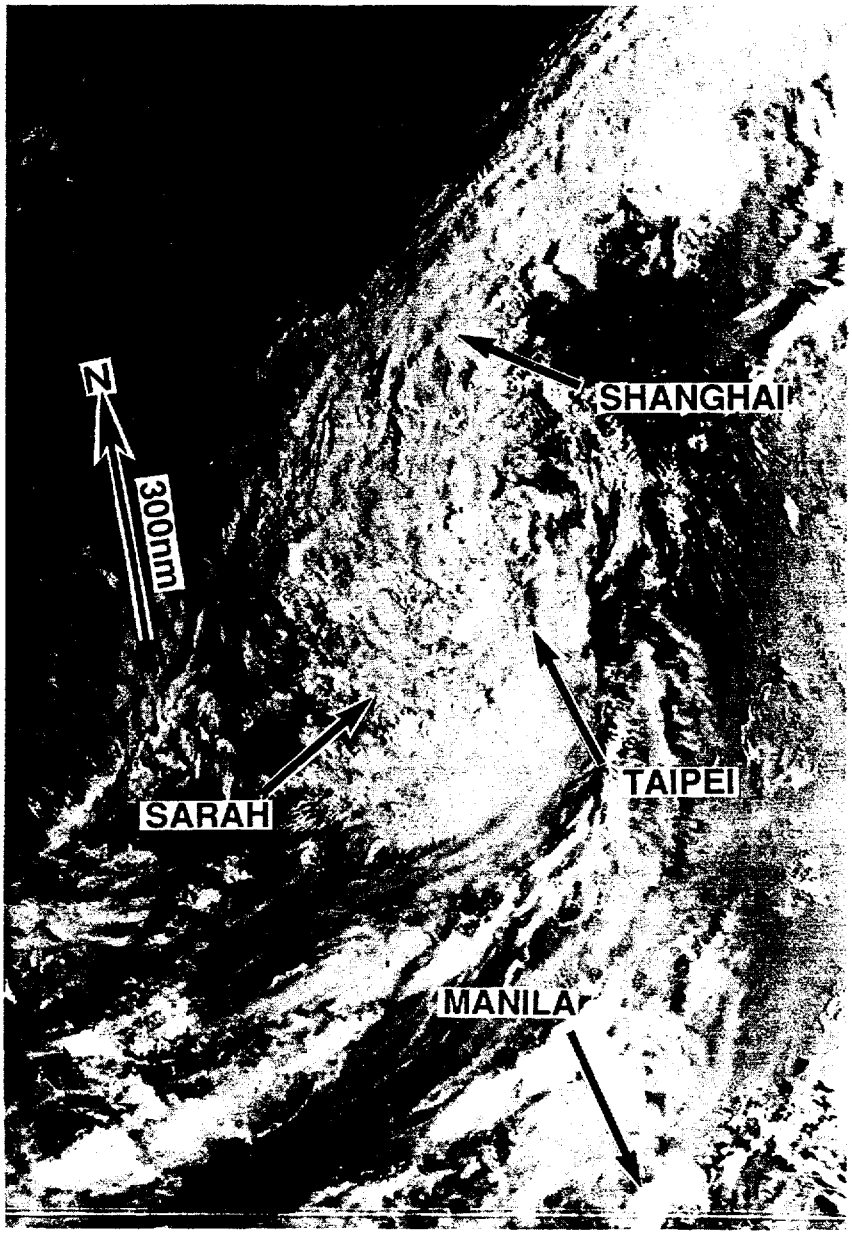


Figure 3-22-5. Sarah weakens over the coast of China (130006Z NOAA visual imagery).

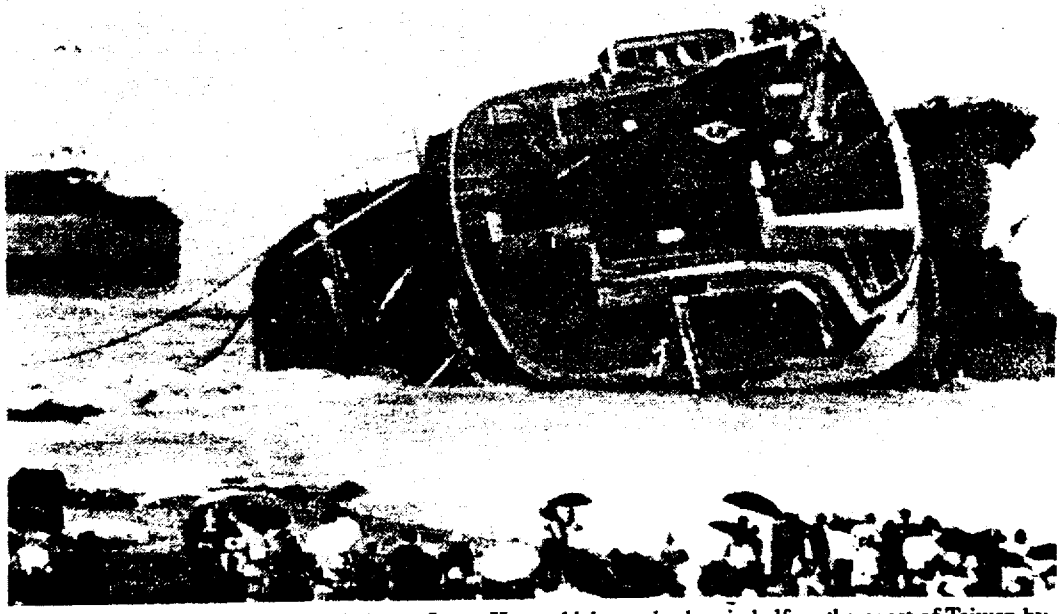


Figure 3-22-6. The wreck of the freighter **Lung Hao**, which was broken in half on the coast of Taiwan by Typhoon Sarah (photo courtesy *Pacific Daily News*, Agana, Guam).